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The first record of external abnormalities in the subterranean *Aegla marginata* Bond-Buckup & Buckup, 1994 (Crustacea: Decapoda: Aeglidae), from a karst area of Southeastern Brazil

Camile Sorbo FERNANDES[1,*], Rafael Augusto GREGATI[2] and Maria Elina BICHUETTE[1]

[1] Laboratório de Estudos Subterrâneos, Departamento de Ecologia e Biologia Evolutiva (DEBE), Universidade Federal de São Carlos - UFSCar. Via Washington Luís, km 235, São Carlos, SP, Brazil, 13565-905; * e-mail: camilesorf@bol.com.br; e-mail: bichuette@uol.com.br

[2] Núcleo de Estudos em Biologia, Ecologia e Cultivo de Crustáceos (NEBECC), Departamento de Zoologia, Universidade Estadual Paulista Júlio de Mesquita Filho, UNESP, Campus de Botucatu. Distrito de Rubião Jr. s/nº, Botucatu, SP, Brazil, 18618-970; e-mail: gregati@ibb.unesp.br

* corresponding author

ABSTRACT

The occurrence of a morphologically altered individual identified as *Aegla marginata* is reported in this note. The specimen was found in the subterranean environment, as part of wider bioespeleological study. The observed abnormalities consist mainly of deformities in abdominal epimera, pleopods, telson and uropods, which could results in difficulties for reproduction and escape from predators. Genetic or nutritional factors related to the scarce food supply observed in the cave environment are admitted as being the most probable cause of the deformities reported here. We emphasize the need of new studies in the area as well as efforts to preserve subterranean environment.

Key words**:** Anomura, abdominal deformities, nutritional factors, genetic factors, cave environment

INTRODUCTION

External abnormalities or deformities are just one of the common problems affecting freshwater and marine crustaceans, and have been reported in many natural crustacean populations (see Lawler and Van Engel 1973; Lira et al 2006; Luppi and Spivak 2007; Beguer et al 2008; Follesa et al 2008; Gregati and Negreiros-Fransozo 2009). The most common problems are modifications on chelipeds (Morgan 1923; Shuster Jr. et al 1963; Zou and Fingerman 2000; Benneti and Negreiros-Fransozo 2003), carapace spines (Moncada and Gomes 1980; Gregati and Negreiros-Fransozo 2009), pereiopods (Lawler and Van Engel 1973) and abdomen shape (Mantellato et al 2000). These alterations could be attributed to genetic factors (Zou and Fingerman 2000), accidents or predation that occurred during the molting process (Moncada and Gomes 1980; Luppi and Spivak, 2007; Follesa et al 2008), besides stress and environmental contamination (Beguer et al 2008).

For crustaceans of the Infraorder Anomura Mac Leay 1838, these records are still scarce. We can cite Nickerson and Gray Jr. (1967) that describe abnormalities on pereiopods of *Paralithodes camtschatica* (Tilesius, 1815) (Lithodidae); Fantucci et al (2008) that report intersexual specimens of *Isocheles sawayai* Forest & Saint-Laurent, 1968 (Diogenidae); and Jara and Palacios (2001) that described the occurrence of conjoined twins in *Aegla abtao* Schmitt, 1942 (Aeglidae).

The Aeglidae Dana, 1852, constitutes a distinctive family of Anomura with characteristic morphology, ecology, and reproduction. They are the only freshwater anomurans. The family consists of two fossil genera and one extant genus, *Aegla* Leach, 1820, which is endemic to temperate South America. The genus contains approximately 70 species and subspecies spread out over Chile, Brazil, Argentina, Uruguay, Paraguay, and Bolivia (Bond-Buckup and Buckup 1994; Pérez Losada et al 2002) in habitats such as lakes, streams, swamps, and caves (Bond-Buckup and Buckup 1994).

The species *Aegla marginata*, is relatively little studied in comparison with other congeneric species. It is known that to occur in both epigean and subterranean environments in Parque Estadual Intervales (PEI), Iporanga city, São Paulo State, southeastern Brazil (Rocha and Bueno 2004). In this region, the *A. marginata* populations present some differences in pigmentation among each other (Morachiolli 1994). As the species is capable of completing its entire life cycle in both subterranean and epigean streams, it is considered as troglophiles (Barr and Holsinger 1985; Morachiolli and Trajano 2002).

The purpose of this note is to present information, for the first time about the occurrence of abdominal abnormalities on a subterranean population of *Aegla marginata*.

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METHODS

As part of a bioespeleological study in the Parque Estadual Intervales (PEI), located in the city of Iporanga in the São Paulo State (Fig. 1), Brazil, anomuran crabs of the genus *Aegla* were sampled inside the cave Gruta Colorida (24º 16'13'' S; 48º 25'09'' W, registration number SP 129) by means of *covo* traps, in May 2009. All of the collected individuals (n= 15) were kept in plastic bags and refrigerated until they were analyzed. The identification was performed according to Buckup and Bond-Buckup (1994). An individual bearing abdominal deformities was identified by similarity with other individuals collected in the same place and occasion, because the second abdominal epimera, an important taxonomic character, was modified (Fig. 2 c). The specimen was photographed and measured under a stereoscope microscope equipped with camera and distances measurement system, and is stored in the scientific collection of the Laboratório de Estudos Subterrâneos, under the following registration numbers: CC1036.

RESULTS

The female specimen with external abdominal deformities was identified as being *Aegla marginata*, measuring 15.5 mm of carapace width and 17.6 mm of carapace length (Fig. 2 a, c, e). Sex was identified by the presence of developed pleopods and the presence of the genital apertures in the coxa of third pair of pereiopods, characters which are present only in females. In ventral position, there are considerable changes in the insertion of pleopods in the abdominal epimera, resulting in a non functional morphology (Fig. 2 a). It is also observed the absence of the fourth and fifth pleopods on the right side of the abdomen.

In dorsal view, the second abdominal epimera is modified, and the third and fourth ones are in abnormal posi-

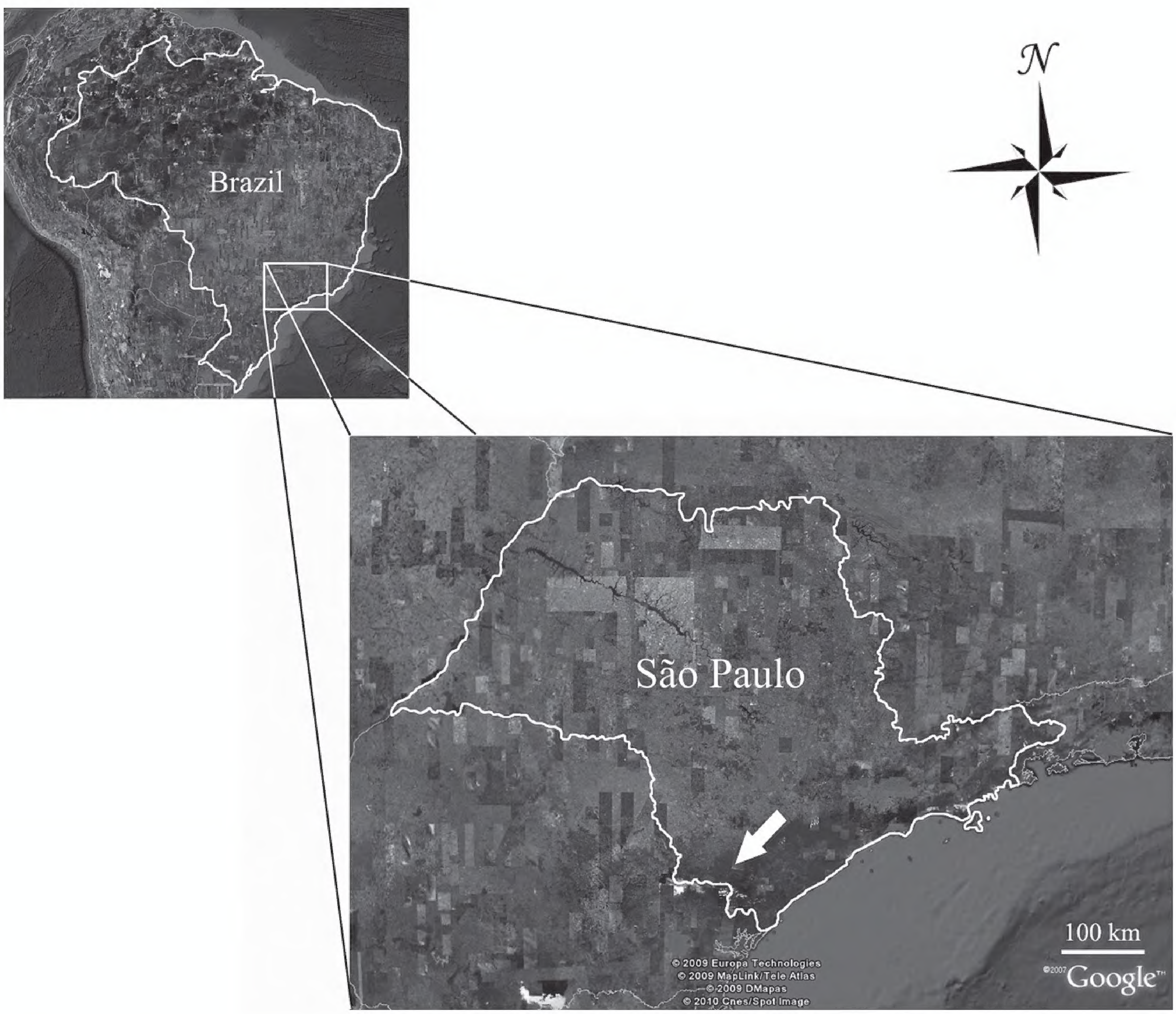

Fig. 1 - Location of Parque Estadual Intervales (PEI), Iporanga, São Paulo State, Brazil (modified from Google Earth (2010), Digital Globe satellite).

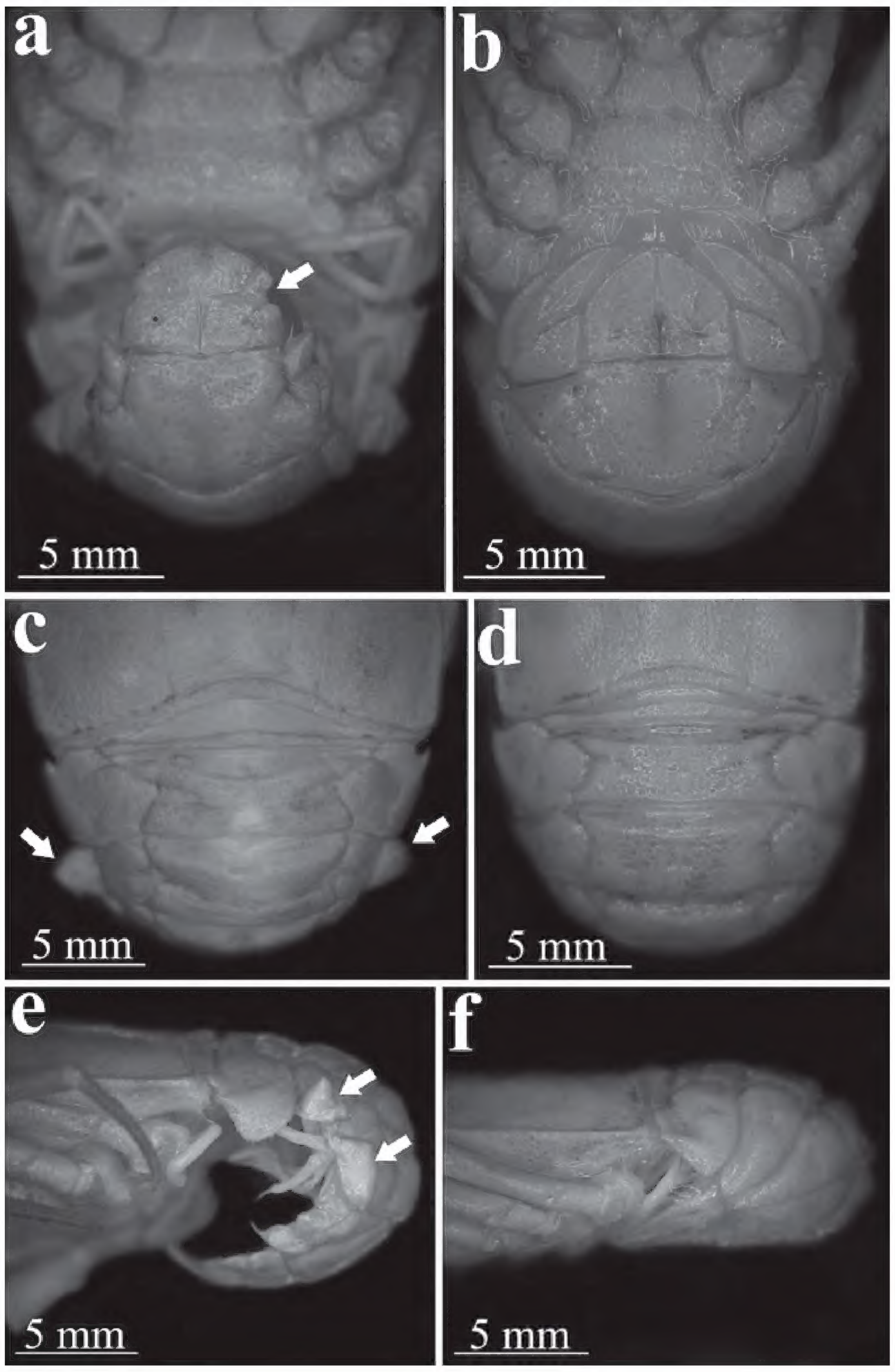

Fig. 2 - *Aegla marginata* on ventral, dorsal and lateral view. **a, c, e)** specimen found with carapace abnormalities; **b, d, f)** normal specimen found on same place. White arrows indicates the abnormalities on abdomen.

tion, folded backwards (Fig. 2 c, e). Between second and third abdominal somites is a flattening of the carapace, forming a scar. The telson is almost divided in two horizontal parts, forming an additional segment. The uropod is reduced to two buds, in both sides.

The other morphological characters are similar to the ones reported in the literature for the species *A. marginata* (Buckup and Bond-Buckup 1994) and for the morphological description of the genus *Aegla* (Martin and Abele 1988).

DISCUSSION

This malformation probably results in difficulties for egg incubation and aeration, as well as juvenile maintenance, since the genus shows evidence of parental care (López-Greco et al 2004). Moreover, as they present caridoid swim reflex (Martin and Abele 1988), probably the pleon deformities would result in greater difficulties to escape predators.

The regeneration of damaged appendages has been reported in the literature for several Decapoda, in case of injury or problems during molting (López-Greco et al. 2001; Luppi and Spivak 2007). This process is often flawed, resulting in scars and deformities (Luppi and Spivak 2007). In the case of the described specimen it is a hypothesis to be considered, although the apparent symmetry of the lesions in the uropods suggests an advanced process of regeneration that, given the extent of the lesions, would have resulted in the death of the individual.

High rates of incidence of anomalies in crustaceans have been associated with the presence of pollution by heavy metals and organophosphates (Betancourt-Lozano et al 2006; Beguer et al 2008; Sánchez et al 2005). Nonetheless, there is a low probability that these pollutants may cause the reported problem, because Moraes (2003), based on chemical analysis of water, sediment and fish tissues, established the levels of these substances as being below the risk levels for the area of Parque Estadual Intervales (PEI). However, new environmental analysis must be accomplished, mostly in benthonic invertebrates.

The subterranean environment depends on allochthonous food intake, which could mean food scarcity (Bichuette and Trajano 2003). As a result, the subterranean populations may have some differences when compared to the epigean ones, mainly in melanic pigmentation, metabolic rates, sex maturation and size (Poulson and White 1969; Mejía-Ortiz and López-Mejía 2005). Depending on the degree of nutritional deficiency, a high level of chronic distress develops, subjecting the individuals to attack by pathogens, which may cause of several deformities in crustaceans (Nunes and Martins 2002 *apud* Barroso 2005; Gregati and Negreiros-Fransozo 2009). Hence, this hypothesis must be considered in the reported case.

Studies with Decapoda species in cultivation environment has demonstrated that populations subjected to inbreeding can present some morphological effects as deformities (De Donato et al 2005), and asymmetries (Maia et al 2009a). In natural decreased populations without gene flow with other populations, the loss of genetic diversity is plausible. That is provided they are subjected to founder effect and genetic drift (Barr 1967; Poulson and White 1969; Trajano 2007), mainly if a reproductive connection with other populations does not occur to replace this loss. In that way, some populations could be subjected to endogamic depression effects and, consequently, to morphological effects in the form of deformities or malformations (Poulson and White op. cit.).

The cave system where the specimen was collected is developed in limestones that occur discontinuously and are interrupted by unsolvable rocks such as granites, phyllites and quartzites (Trajano 1991; Bichuette 1998). This fact suggests reduced gene flow between caves, since unsolvable rocks could limit the contact between populations by isolating the caves.

Evidence that *A. marginata* populations can be isolated was observed in the work of Morachiolli (1994), who found populations of the same species showing different levels of pigmentation in the same cave system. However,

it is not known if that is due to genetic differences, pigments eaten by epigean individuals, food type, or absence of light in hypogean environment necessary to aggregate some pigments (Cullingford 1962; Morachiolli 1994).

The absence of light has also been reported in the literature as responsible for deformations in nontroglobitic (acidental) fishes. Rasqueen and Rosenbloom (1954) *apud* Poly and Boucher (1996), reported the occurrence of esqueletal deformations associated with darkness in epigean individuals of *Astyanax mexicanus* (De Filippi, 1853) maintained in absence of light in the laboratory, possibly due to hormonal imbalance. Other deformations that could be associated with subterranean environment were the lack of pelvic fins or deformed caudal fins in *Ameiurus natalis* (Lesueur, 1819) (Relya and Sutton (1973) *apud* Poly and Boucher (1996).

We speculate that absence of light is not responsible for deformations observed in *A. marginata*, because this species is generally considered to be a troglophile (Morachiolli and Trajano 2002). It is therefore well adapted and capable of completing its entire life cycle in a subterranean environment.

The distribution of the genus *Aegla*, which is restricted to temperate and subtropical South America (Bond-Buckup and Buckup 1994), contributes to its vulnerability (IUCN, 2001). In addition the situation is aggravated by the present drastic reduction of populations in the Ribeira Valley (Maia et al 2009 b) and, possibly, by the founder effect and increased homozygosity, both very common in subterranean populations (Barr 1967). According Brook et al (2002), Spielman et al (2004) and Buhay and Crandall (2005), loss of heterozigosity and inbreeding play an important role in the extinction of threatened species. Therefore, we could consider the need of studies related to effective population size and genetic diversity in this population (Buhay and Crandall 2005), as well as efforts to preserve subterranean environment.

In as much as only one specimen was registered with anomalies, it is not possible to establish if these problems occur by chance, or are influenced by the above mentioned factors. Genetic or nutritional factors are suggested as being the most probable cause of the deformities reported here.

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